Name: Date:

## s19 Matrix Exam (solution v1)

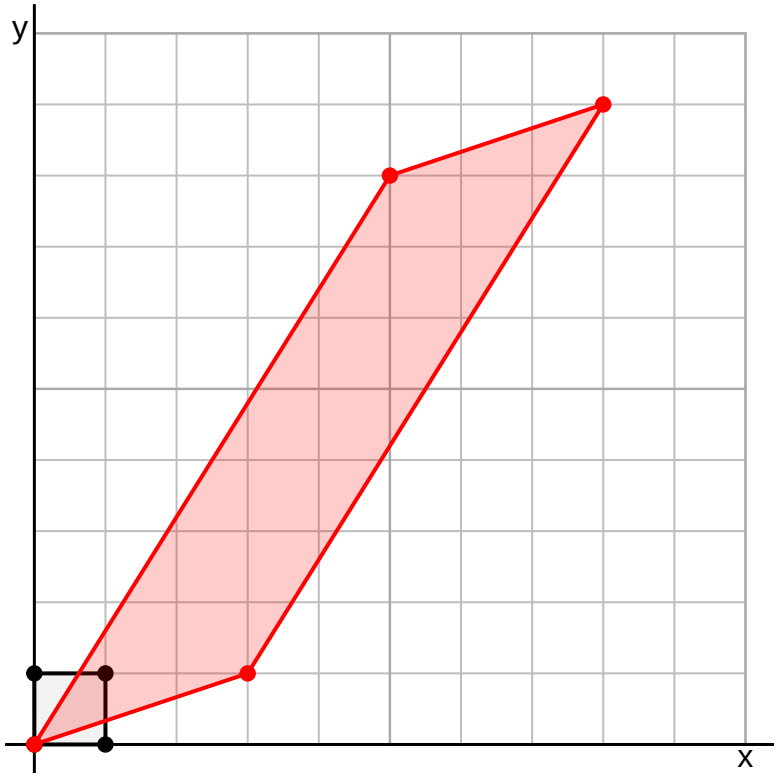
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 3 & 5 \\ 1 & 8 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 3 | 5 | 0 | 3 | 8 | 5 |
| 1 | 8 | 0 | 1 | 9 | 8 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (3 \cdot 8) - (5 \cdot 1)$$

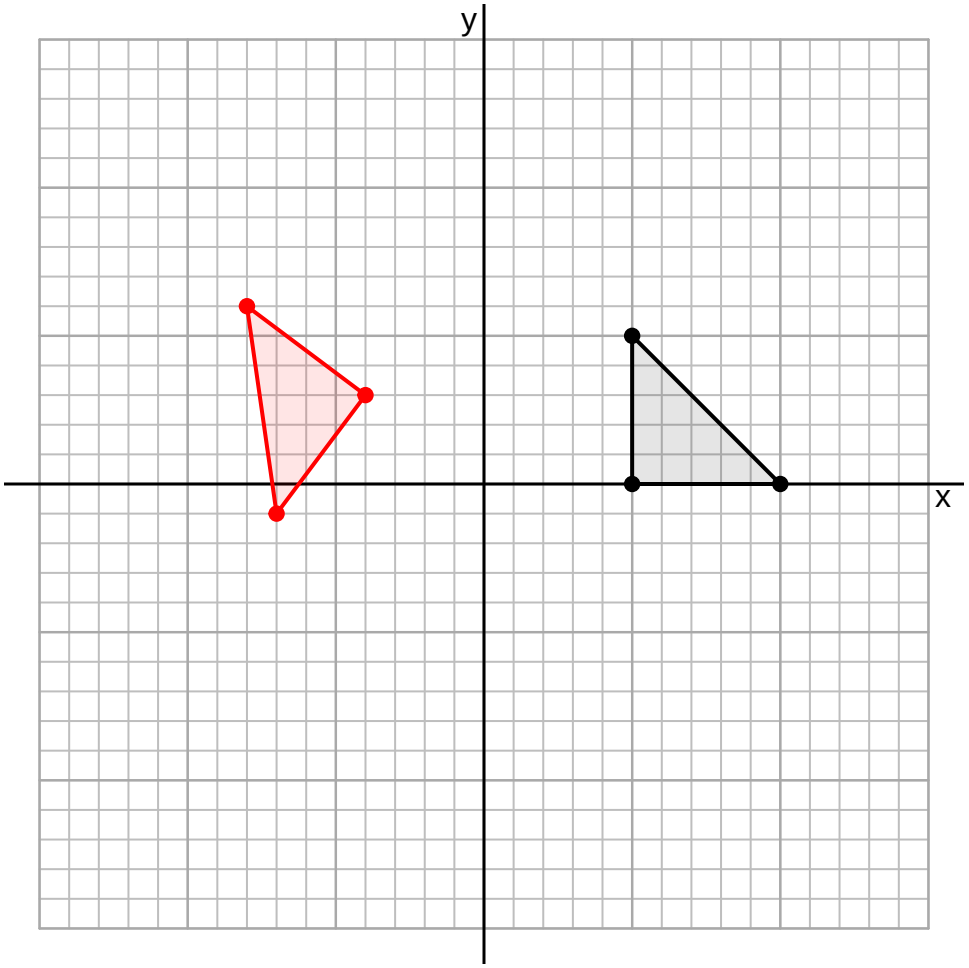
$$\text{area} = 19$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 5 & 10 \\ 5 & 0 & 0 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 323.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.8 & -0.6 \\ 0.6 & -0.8 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -7 & -4 & -8 \\ -1 & 3 & 6 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v2)

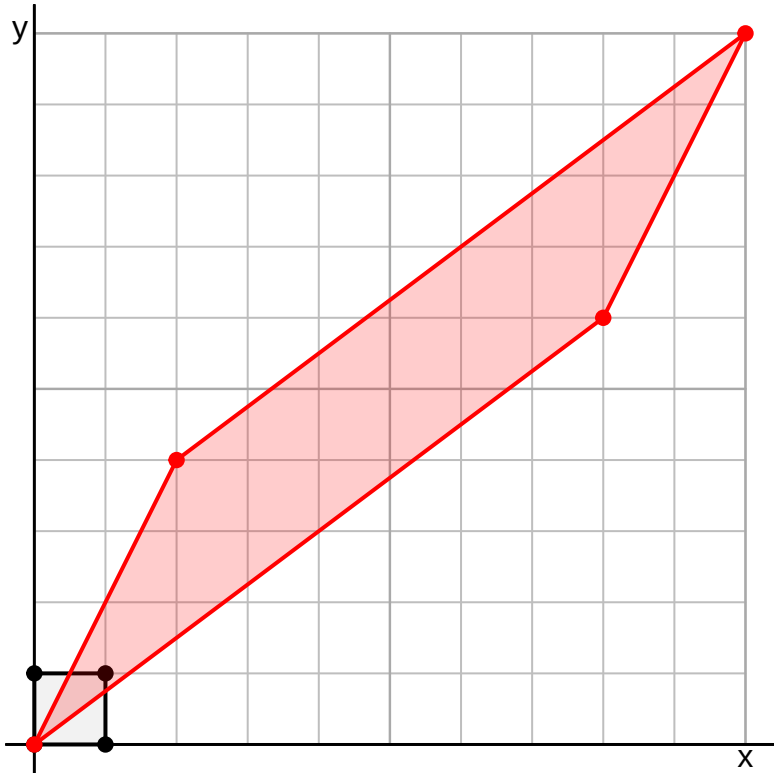
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 8 & 2 \\ 6 & 4 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 8 | 2 | 0 | 8 | 10 | 2 |
| 6 | 4 | 0 | 6 | 10 | 4 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (8 \cdot 4) - (2 \cdot 6)$$

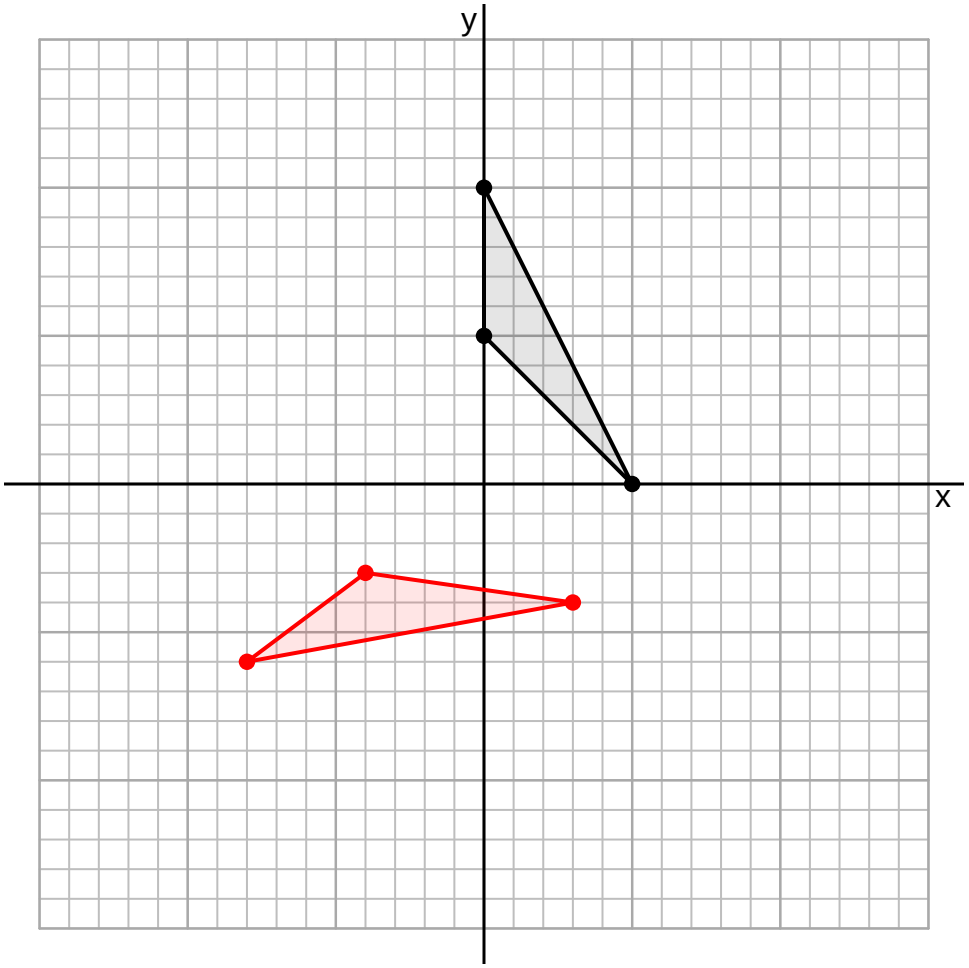
$$\text{area} = 20$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 0 & 5 & 0 \\ 10 & 0 & 5 \end{bmatrix}$. In order to reflect over the $x$ axis and then rotate by 306.87° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} 0.6 & -0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -8 & 3 & -4 \\ -6 & -4 & -3 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v3)

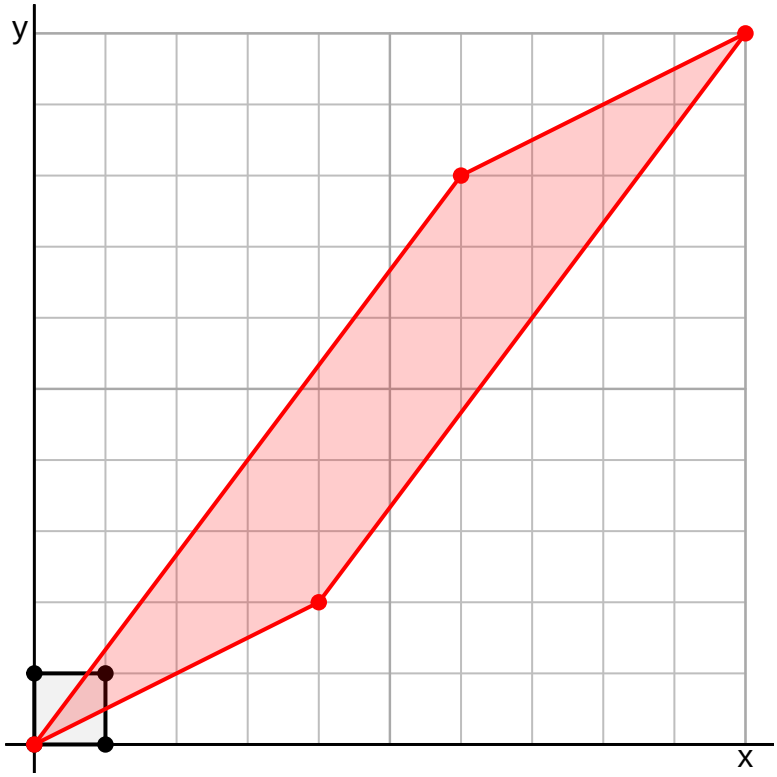
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 4 & 6 \\ 2 & 8 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 4 | 6 | 0 | 4 | 10 | 6 |
| 2 | 8 | 0 | 2 | 10 | 8 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (4 \cdot 8) - (6 \cdot 2)$$

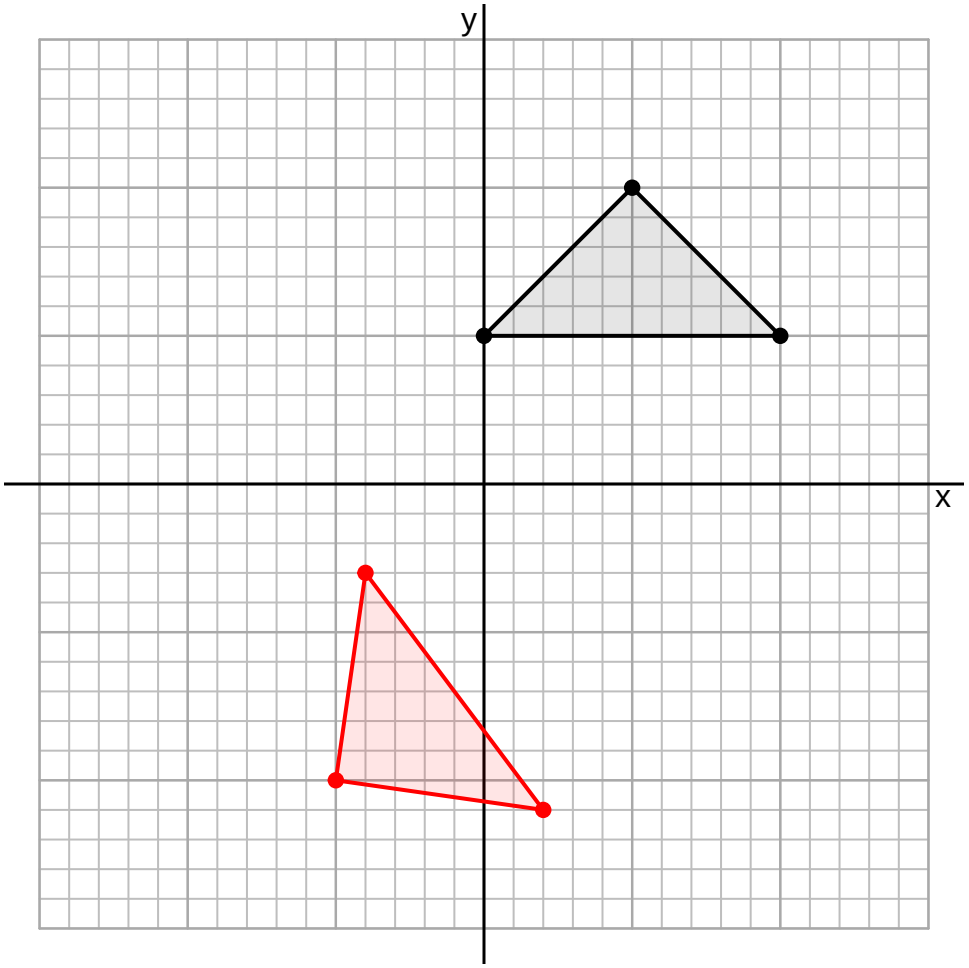
$$\text{area} = 20$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 0 & 10 \\ 10 & 5 & 5 \end{bmatrix}$. In order to reflect over the $x$ axis and then rotate by 306.87° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} 0.6 & -0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -5 & -4 & 2 \\ -10 & -3 & -11 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v4)

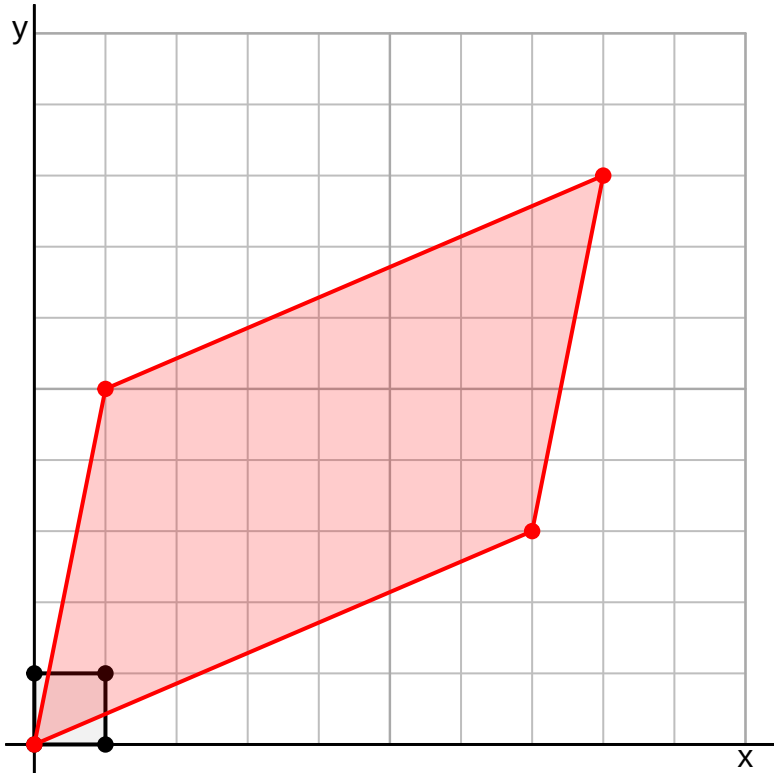
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 7 & 1 \\ 3 & 5 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 7 | 1 | 0 | 7 | 8 | 1 |
| 3 | 5 | 0 | 3 | 8 | 5 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (7 \cdot 5) - (1 \cdot 3)$$

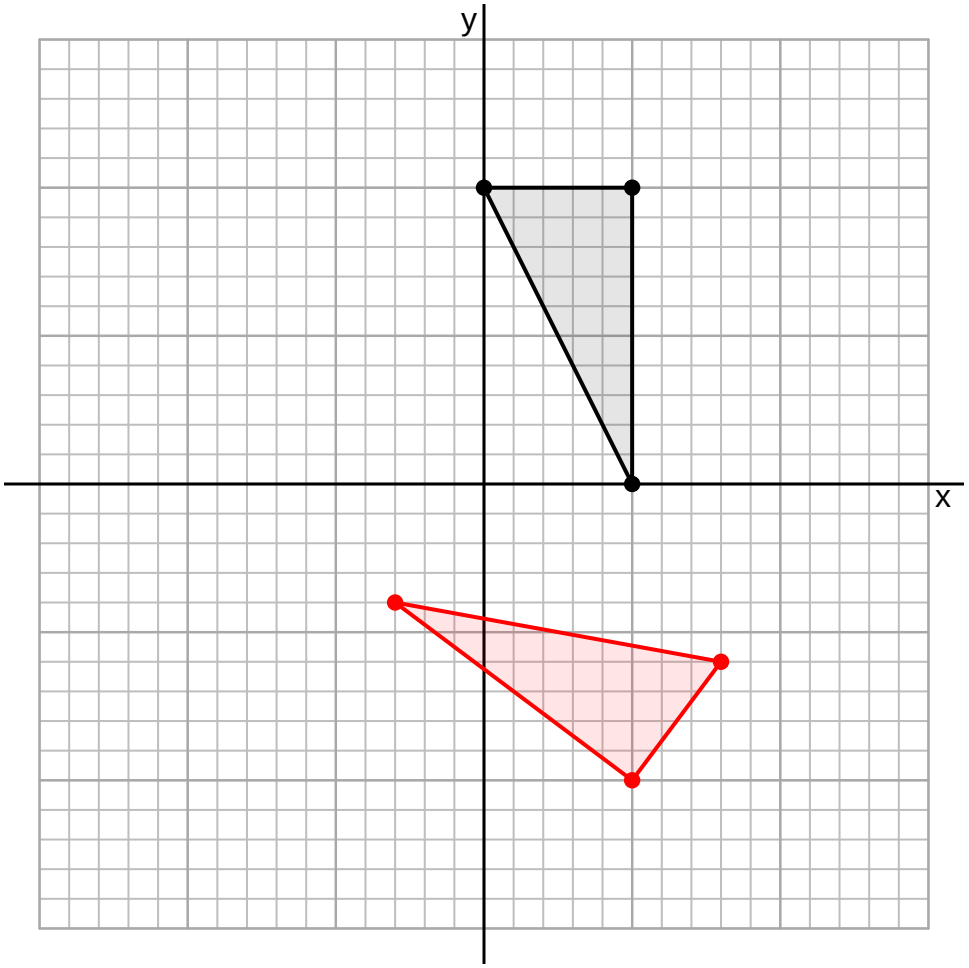
$$\text{area} = 32$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 0 & 5 \\ 0 & 10 & 10 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 53.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.6 & 0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -3 & 8 & 5 \\ -4 & -6 & -10 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v5)

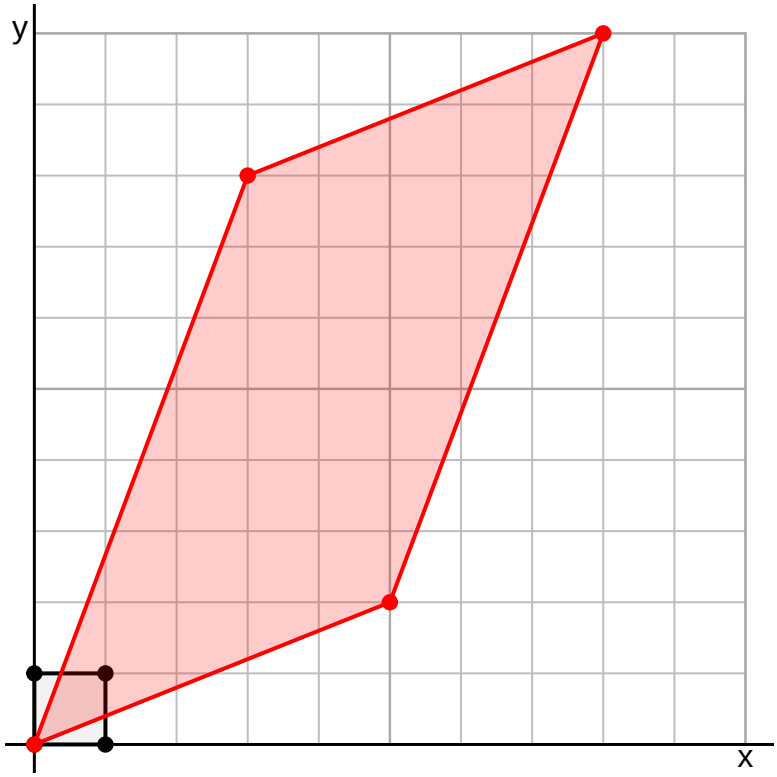
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 5 & 3 \\ 2 & 8 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 5 | 3 | 0 | 5 | 8 | 3 |
| 2 | 8 | 0 | 2 | 10 | 8 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (5 \cdot 8) - (3 \cdot 2)$$

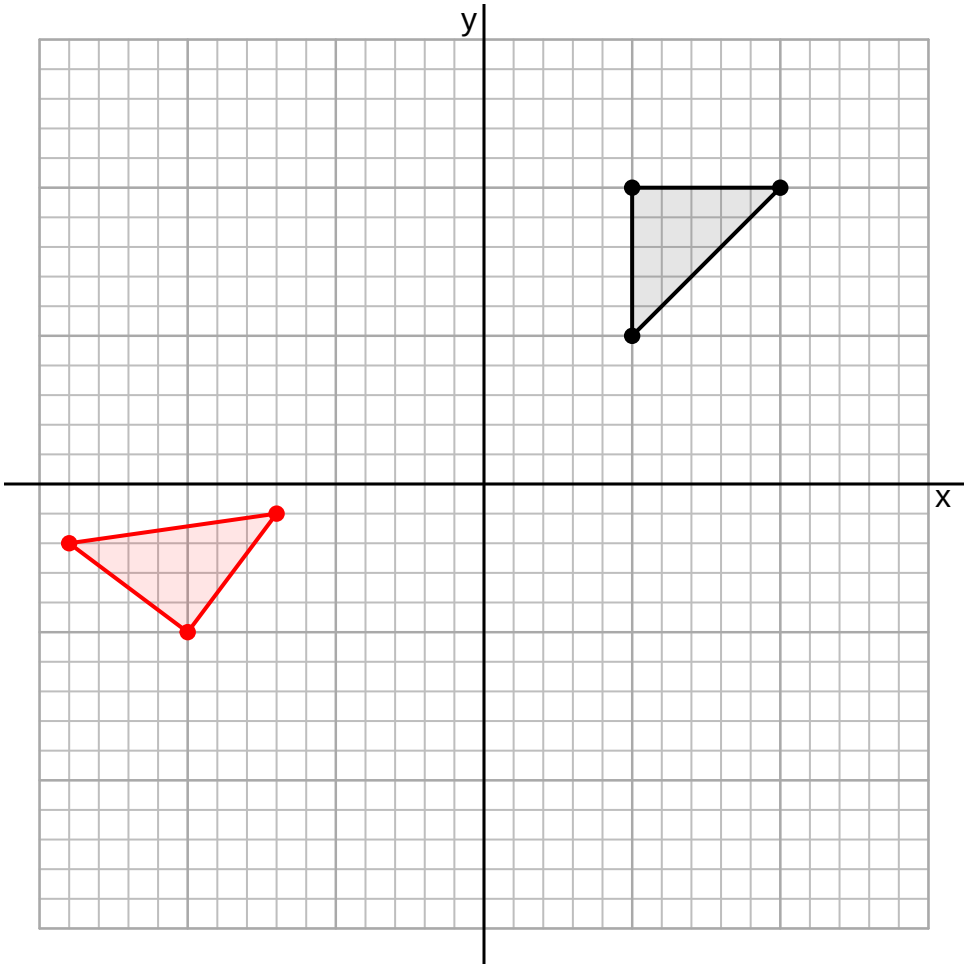
$$\text{area} = 34$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 10 & 5 \\ 10 & 10 & 5 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 323.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.8 & -0.6 \\ 0.6 & -0.8 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -10 & -14 & -7 \\ -5 & -2 & -1 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v6)

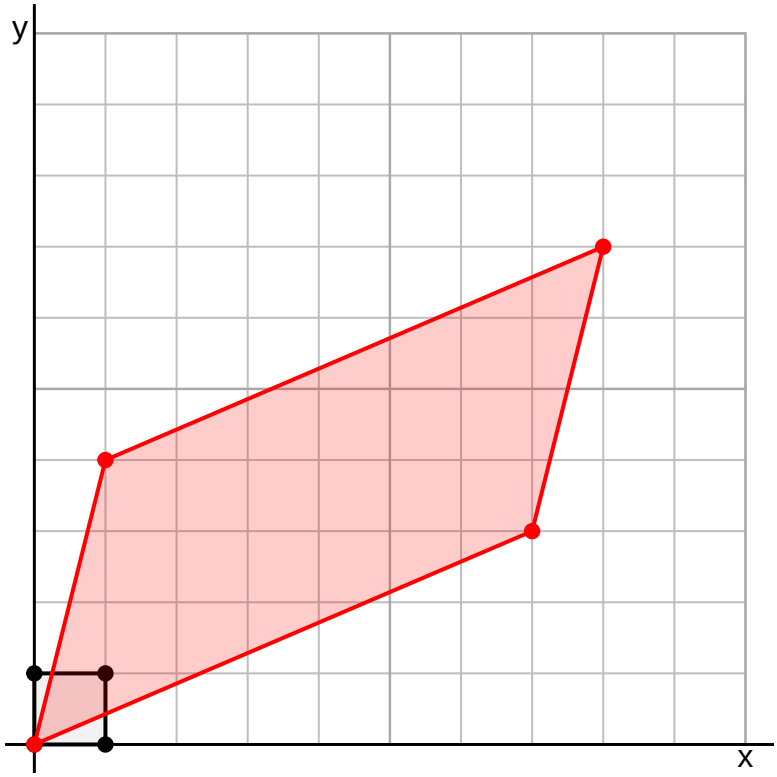
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 7 & 1 \\ 3 & 4 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 7 | 1 | 0 | 7 | 8 | 1 |
| 3 | 4 | 0 | 3 | 7 | 4 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (7 \cdot 4) - (1 \cdot 3)$$

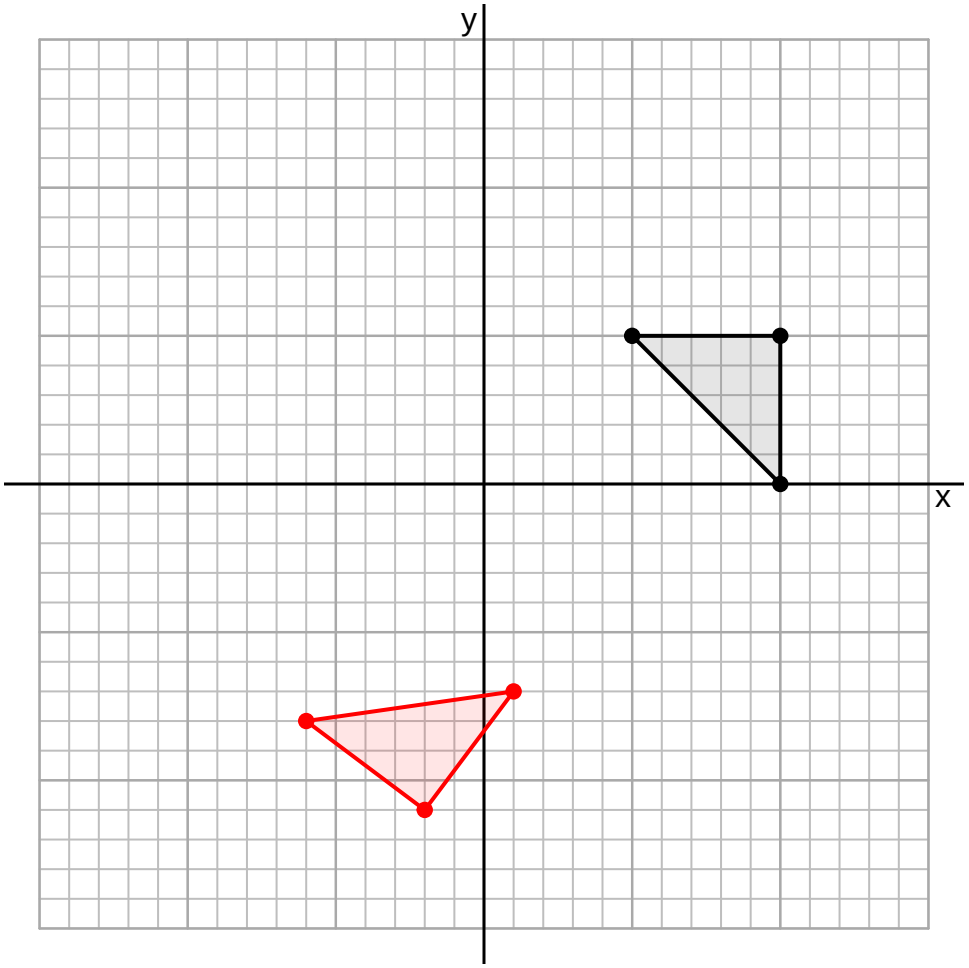
$$\text{area} = 25$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 10 & 10 \\ 5 & 0 & 5 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 53.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.6 & 0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} 1 & -6 & -2 \\ -7 & -8 & -11 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v7)

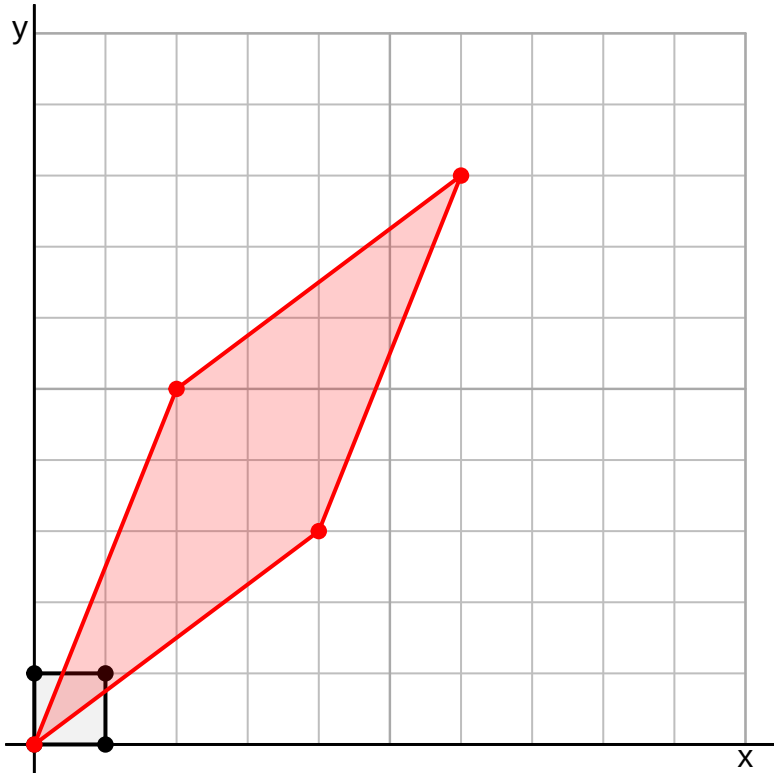
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 4 & 2 \\ 3 & 5 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 4 | 2 | 0 | 4 | 6 | 2 |
| 3 | 5 | 0 | 3 | 8 | 5 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (4 \cdot 5) - (2 \cdot 3)$$

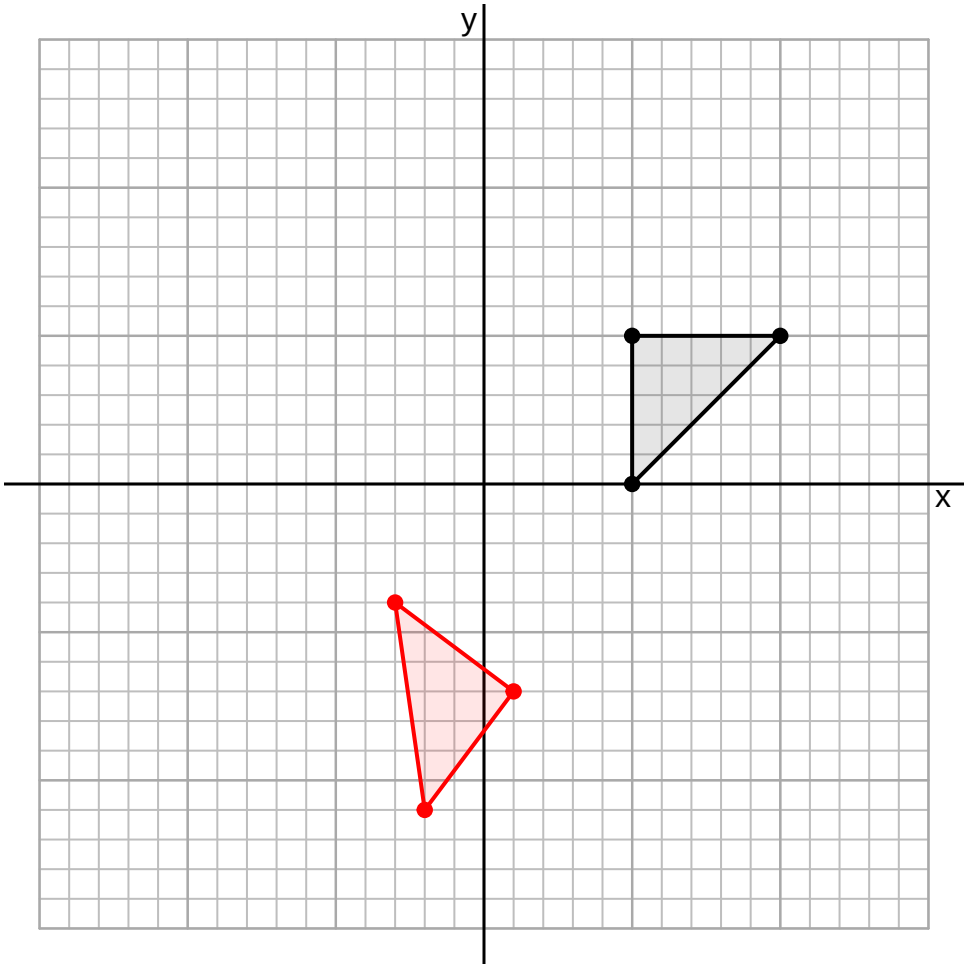
$$\text{area} = 14$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 10 & 5 \\ 0 & 5 & 5 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 53.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.6 & 0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -3 & -2 & 1 \\ -4 & -11 & -7 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v8)

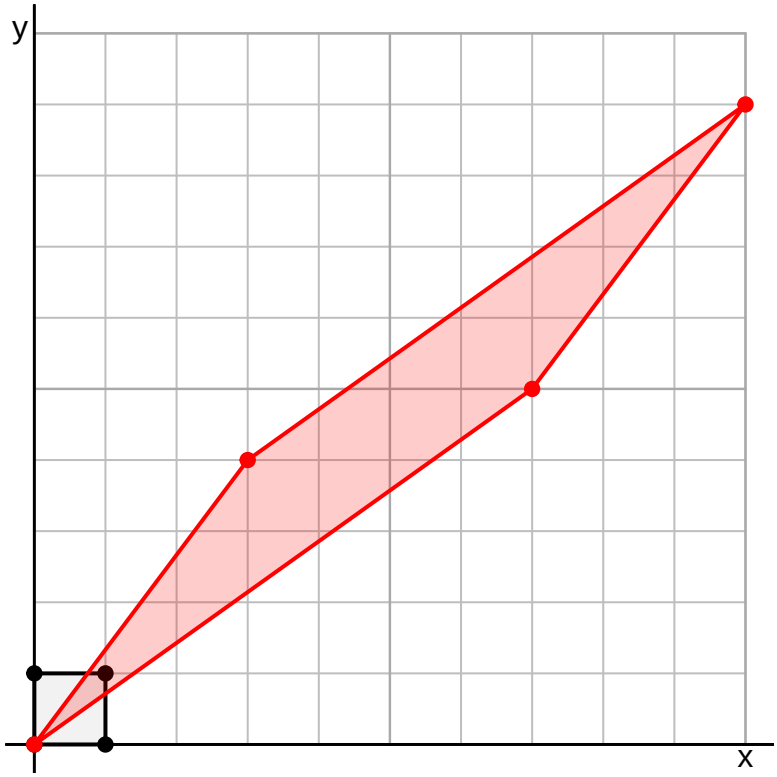
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 7 & 3 \\ 5 & 4 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 7 | 3 | 0 | 7 | 10 | 3 |
| 5 | 4 | 0 | 5 | 9 | 4 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (7 \cdot 4) - (3 \cdot 5)$$

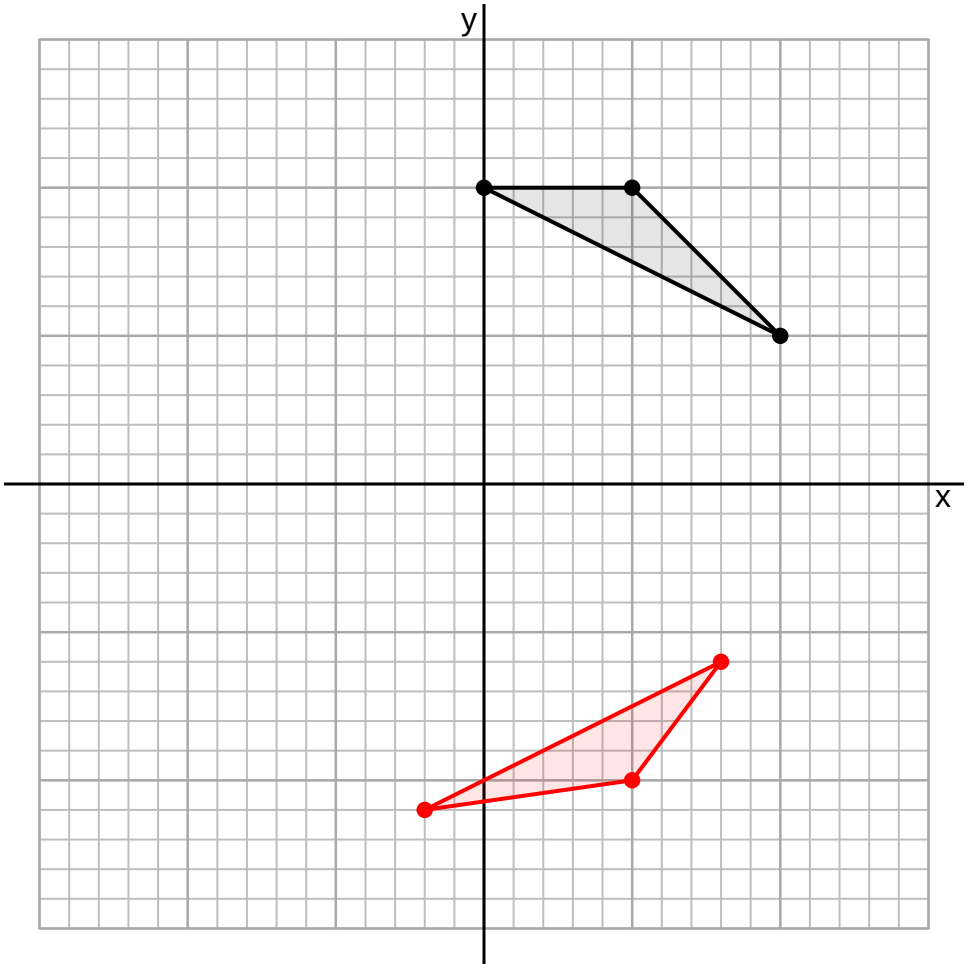
$$\text{area} = 13$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 10 & 0 & 5 \\ 5 & 10 & 10 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 53.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.6 & 0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -2 & 8 & 5 \\ -11 & -6 & -10 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v9)

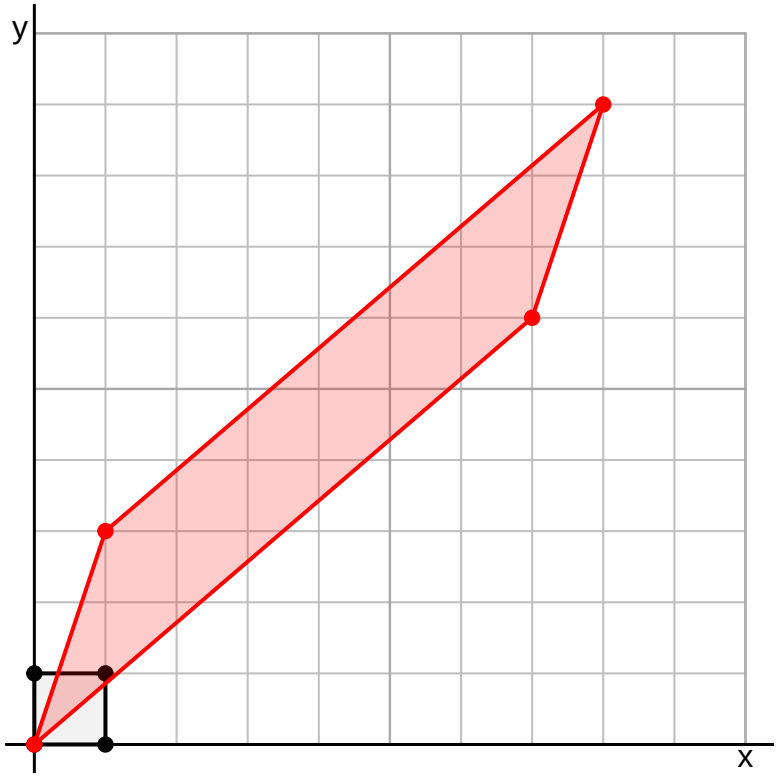
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 7 & 1 \\ 6 & 3 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 7 | 1 | 0 | 7 | 8 | 1 |
| 6 | 3 | 0 | 6 | 9 | 3 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (7 \cdot 3) - (1 \cdot 6)$$

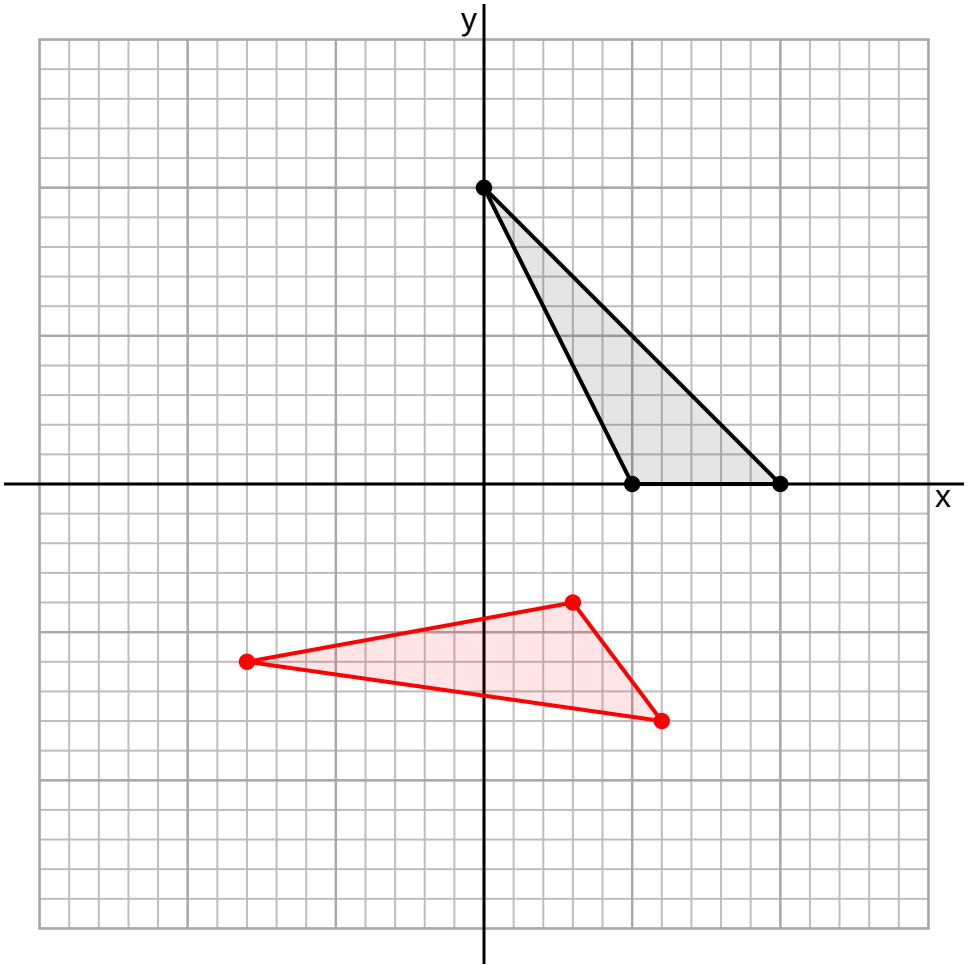
$$\text{area} = 15$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 0 & 10 \\ 0 & 10 & 0 \end{bmatrix}$. In order to reflect over the $y$ axis and then rotate by 126.87° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} 0.6 & -0.8 \\ -0.8 & -0.6 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} 3 & -8 & 6 \\ -4 & -6 & -8 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.



Name: Date:

## s19 Matrix Exam (solution v10)

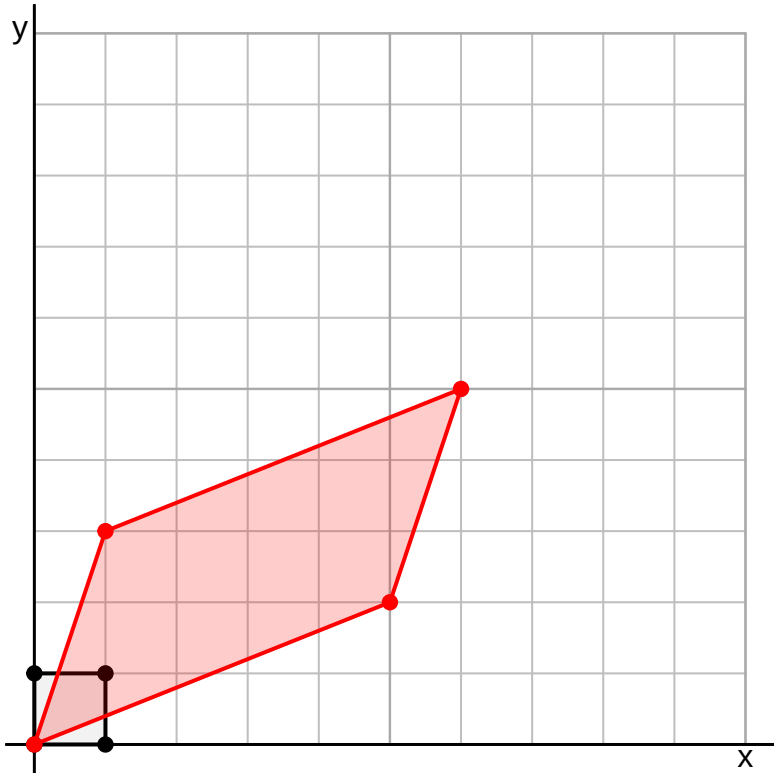
Let the $2 \times 4$ matrix $U$ represent four points in the $xy$-plane (so each column represents a point). When those four points are connected as a convex polygon, matrix $U$ represents a unit square. Also, let the $2 \times 2$ matrix $L$ represent a linear transformation.

$$U = \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix} \qquad L = \begin{bmatrix} 5 & 1 \\ 2 & 3 \end{bmatrix}$$

Let matrix $P = L \cdot U$, so $P$ is found by matrix multiplication of $L$ times $U$. Matrix $P$ also represents 4 points of a polygon. Use the diagram below to calculate the elements of $P$. Then, draw the polygon represented by matrix $P$ on the $xy$-plane below. Notice I have already drawn the unit square represented by matrix $U$.

1. Multiply $L \cdot U$ and draw resulting polygon.

| | | 0 | 1 | 1 | 0 |
|---|---|---|---|---|---|
| | | 0 | 0 | 1 | 1 |
| 5 | 1 | 0 | 5 | 6 | 1 |
| 2 | 3 | 0 | 2 | 5 | 3 |




2. What is the area of the convex polygon represented by matrix $P$? *Hint: the area equals the absolute value of the determinant of matrix $L$.*

$$\text{area} = \det(L) = (5 \cdot 3) - (1 \cdot 2)$$

$$\text{area} = 13$$

The triangle shown below is composed of the three points represented by matrix $A = \begin{bmatrix} 5 & 10 & 5 \\ 5 & 0 & 0 \end{bmatrix}$. In order to reflect over the $x$ axis, reflect over the $y$ axis, and then rotate by 323.13° counterclockwise we can multiply by the transformation matrix $R = \begin{bmatrix} -0.8 & -0.6 \\ 0.6 & -0.8 \end{bmatrix}$.

3. Calculate the matrix $R \cdot A$.

$$R \cdot A = \begin{bmatrix} -7 & -8 & -4 \\ -1 & 6 & 3 \end{bmatrix}$$

4. Draw the triangle represented by $R \cdot A$.